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INTRODUCTION

Persimmon (Diospyros virginiana L.) and sassafras (Sassafras albidum (Nutt.) Nees.) are common invaders of pasture and range lands in the Central States Region (fig. 1). Both species are profuse root sprouters and are expensive and difficult to eliminate by mechanical methods (fig. 2). 2,4-D and 2,4,5-T are being used to reduce the cost of controlling these species but the results are often disappointing. The study described in this report was a screening test preliminary to more formal experiments. It was initiated to determine some of the sources of variation in results obtained with 2,4-D and 2,4,5-T and especially to determine whether or not there were any striking differences in effectiveness among the common types of commercial 2,4-D and 2,4,5-T formulations.

Figure 1.--Sassafras and persimmon readily invade old fields and pastures and, once established, they are hard to eliminate. Only three growing seasons have elapsed since this area was cleared, plowed, and seeded to pasture. The taller trees, most of which are sprouts, already are over 12 feet tall.

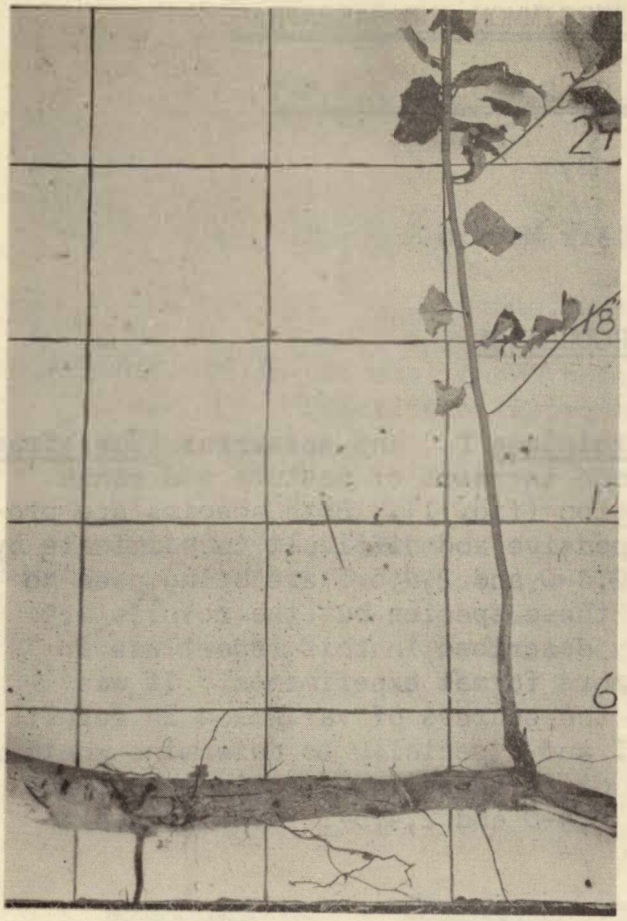

Figure 2.--Unlike many species which sprout only from stem tissue, sassafras and persimmon sprout from root tissue as well. This persimmon sprout, on one of the major horizontal roots, emerged about 2 feet from the dead parent stem. On sassafras, sprouts commonly originate on roots one-half inch in diameter or smaller.

METHODS

The study was conducted on a ridge old field on the Ashland Wildlife Area in Boone County, Missouri. It was limited to persimmon and sassafras saplings in the 1-inch, 2-inch, and 3-inch d.b.h. classes. The 15 herbicides involved in the tests are listed below according to the groupings used in discussion of results.

Basic herbicide	Type of formulation		
	Non-esters	Alkyl esters	Glycol esters
2,4-D	1. Acid	6. Butyl	13. Propylene glycol
	2. Amine	7. Isopropyl	
	3. Sodium salt	8. Isopropyl	
	4. Sodium salt		
2,4,5-T	5. Amine	9. Isopropyl	14. Propylene glycol
		10. Isopropyl	
		11. Isopropyl	
50% 2,4-D and 50% 2,4,5-T		12. Isopropyl	15. Propylene glycol

All herbicides were applied June 1-2, 1950, at concentrations of 2.0 percent (acid equivalent basis), and at the rate of 1 quart of solution per 10 trees. The two carriers were kerosene and paste. The paste was composed of four parts water and one part kerosene thickened with wheat flour to the approximate consistency of pancake batter. Kerosene solutions were applied with a sprayer and the pastes with a paint brush to the lower 12 inches of trunk. Each treatment was applied to 10 numbered trees. Two groups of 10 trees each, which were cut but not treated with herbicides, served as checks.

RESULTS

Tabular data presented in this paper are for "Percent apparent kill," i.e., that percentage of the treated trees which had dead tops and no living sprouts at the time of observation. All data, except those otherwise identified in table 4, are based on the August 1952 observation.

Herbicides tested included ester and amine forms of 2,4,5-T, and ester, amine, salt, and acid formulations of 2,4-D. Examination of the data indicated that differences in percent apparent kill were rather small among either the ester or the non-ester formulations but that differences between ester and non-ester forms were striking. Consequently, all herbicides have been grouped for comparison into "ester" and "non-ester" forms. Ester formulations were markedly superior to non-ester formulations for persimmon but the two forms were about equally effective on sassafras (table 1).

Table 1.--Average percent apparent kill on persimmon and sassafras with ester and non-ester formulations of 2,4-D and 2,4,5-T

Carrier	2,4-D				2,4,5-T			
	Ester		Non-ester		Ester		Non-ester	
	Herbicides 1/	Kill	Herbicides	Kill	Herbicides	Kill	Herbicides	Kill
		Percent		Percent		Percent		Percent
Persimmon								
Kerosene	6,7,8,13	42	1,2,3,4	5	9,10,11,14	95	5	0
Paste	6,13	45	2	0	10,11,14	30	5	0
Sassafras								
Kerosene	6,13	100	2	100	10,11,14	100	5	100
Paste	6,13	60	2	60	10,11,14	83	5	70

1/ Herbicide numbers correspond to those given in the tabulation on page 2.

Esters of polyatomic alcohols (glycol esters) are a relatively recent development in 2,4-D and 2,4,5-T formulations. These glycol esters of 2,4-D and 2,4,5-T are reported to be less volatile and perhaps more effective than comparable alkyl esters. In this study, apparent kills obtained with the two types of esters were essentially equal on both persimmon and sassafras (table 2).

Table 2.--Average percent apparent kill on persimmon and sassafras with alkyl and glycol esters of 2,4-D and 2,4,5-T

Carrier	Persimmon		Sassafras	
	Alkyl esters (6,10,11,12)	Glycol esters (13,14,15)	Alkyl esters (6,10,11,12)	Glycol esters (13,14,15)
	Percent			
Kerosene	98	87	100	100
Paste	30	30	40	30

Over-all comparisons indicate that paste applications of 2,4-D and 2,4,5-T were about equally effective on both persimmon and sassafras (table 3). Kerosene solutions of 2,4,5-T were superior to kerosene solutions of 2,4-D for persimmon but on sassafras 100 percent apparent kills resulted from all kerosene applications of both 2,4-D and 2,4,5-T.

Table 3.--Average percent apparent kill on persimmon and sassafras by types of carriers and basic herbicides

Basic herbicide	Persimmon		Sassafras	
	Herbicides tested	Average apparent kill	Herbicides tested	Average apparent kill
		Percent		Percent
		KEROSENE		
2,4-D	2,6,7,8,13	34	2,6,13	100
2,4,5-T	5,9,10,11,14	76	5,10,11,14	100
		PASTE		
2,4-D	2,6,13	30	2,6,13	60
2,4,5-T	5,10,11,14	22	5,10,11,14	80

The study also included two ester formulations which were 50-50 mixtures of 2,4-D and 2,4,5-T. On both persimmon and sassafras the apparent kills obtained with the mixtures were essentially equal to those obtained with esters of 2,4,5-T alone.

These data suggest that relative cost should be a major consideration in deciding which formulation to use on sassafras. On the other hand, the only combinations that produced satisfactory kills on persimmon were kerosene solutions which contained ester forms of 2,4,5-T. Thus, for control of persimmon, or for mixed species including persimmon, preparations containing ester forms of 2,4,5-T should be specified. In mixtures of 2,4-D and 2,4,5-T there is some question about how much the 2,4-D contributes to the effectiveness of the mixture for persimmon. However, since all 2,4,5-T esters gave good results and 2,4-D esters gave only fair results (table 1), it is suspected that the formulation which provides the most 2,4,5-T ester per dollar probably is the best buy.

Two questions which puzzle all researchers in woody plant control are: How soon after treatment can I tell which plants are dead? Will the apparent kill 6 months or 1 year after treatment be greater or less than one or two seasons later? Because persimmon and sassafras are root sprouters, the problem of knowing when to appraise the results of herbicide applications is especially difficult. Scattered reports indicate that persimmon treated with 2,4,5-T will sometimes sprout vigorously from the roots after showing no signs of life for two or more growing seasons. There is some evidence that sassafras behaves similarly. Some of the types of variation obtained in this study are illustrated in table 4.

Table 4.--Average percent apparent kill on three successive dates for persimmon and sassafras by treatments

Treatment	Carrier	Dates		
		September 1950	July 1951	August 1952
		-Percent-		
Persimmon				
Basal herbicide applications	Kerosene	16	62	72
	Paste	3	14	23
Trees cut; no herbicide applications	None	25	20	15
Sassafras				
Basal herbicide applications	Kerosene	100	100	100
	Paste	49	68	71
Trees cut; no herbicide applications	None	15	10	10

The data in table 4 indicate that the apparent kill for groups of check trees, which were cut but not treated with herbicide, was lower on each succeeding observation. The apparent kills obtained on sassafras with kerosene solutions of 2,4-D and 2,4,5-T (100 percent for each observation date) are at the other extreme and seem too good to believe. Perhaps results would have been different if lower concentrations or rates of application had been used.

The most interesting data in table 4 are those for herbicide treatments that were only moderately effective. There is encouragement in the fact that the apparent percent kill for these treatment groups increased with time. Thus far, at least, early estimates of kill appear to have been conservative rather than exaggerated. However, several "apparently dead" sassafras and persimmon trees were grubbed out in September 1952. All had live roots. It must therefore be assumed that many of the other "apparently dead" trees have live roots too, and that these live roots may sprout (fig. 3).

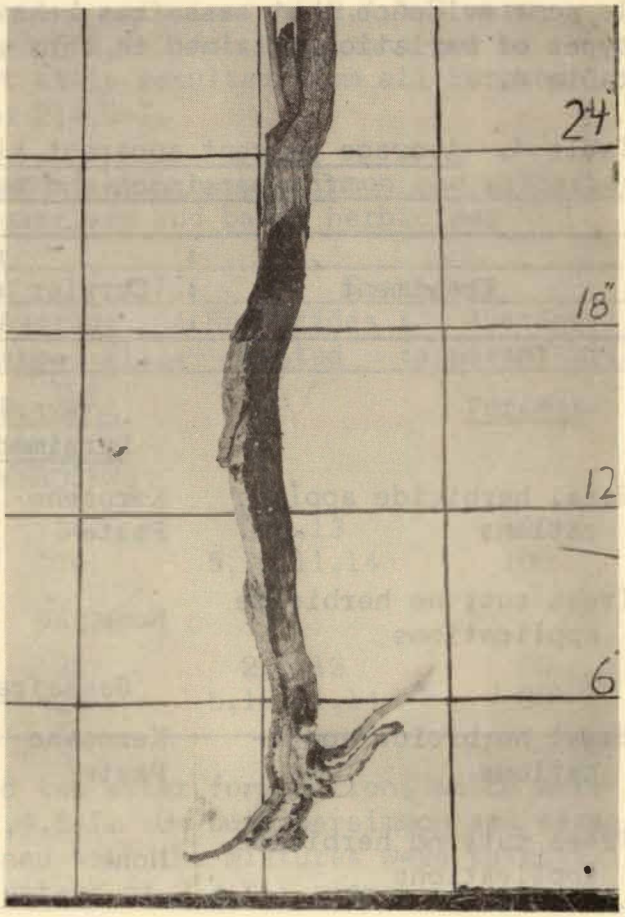

Figure 3.--This sassafras, which was treated in June 1950, was grubbed out and photographed in September 1952. The top was dead and the central root was dead down to about 18 inches below the soil surface, as indicated by the dark color along the right-hand side of the root where the bark has been removed. Below 18 inches there was live tissue, especially in the relatively small lateral roots. In persimmon, too, the central root usually was dead but most of the lateral roots were alive.

One consistent relationship apparent in all the data presented is that 2,4-D and 2,4,5-T were more effective when applied in kerosene than when applied in paste. Two notable exceptions were: (1) Ester forms of 2,4-D which appeared to be about equally effective on persimmon in either carrier and (2) non-ester forms of 2,4-D and 2,4,5-T which were almost totally ineffective against persimmon in either kerosene or paste.

The superiority of oil solutions over water emulsions for basal bark treatments was recognized generally at the time this study was initiated. However, there were also many indications that oil solutions might act too fast to permit adequate translocation and that a carrier which would supply herbicide to the plant at a slower rate over a longer period of time might be more effective. It was hoped that the paste might be such a carrier. The superiority of kerosene over the paste in these tests was undoubtedly due to better surface coverage and deeper penetration.

Another relationship that reappears in all the data is that apparent kills on persimmon almost invariably were lower than apparent kills on sassafras. These differences were greatest at the time of the first observation and least when the last observation was made.

SUMMARY

Several formulations each of 2,4-D and 2,4,5-T were applied in kerosene and in paste as basal bark treatments to sassafras and persimmon in June 1950. Apparent kill data taken September 1950, July 1951, and August 1952, indicate some of the ways in which apparent results change with time. Data on percent apparent kill as of August 1952, provide the basis for comparing the effectiveness of different formulations on each species.

Ester forms of 2,4-D and 2,4,5-T were superior to non-ester formulations for killing persimmon but the two forms were equally effective on sassafras. Likewise, 2,4,5-T was superior to 2,4-D for persimmon but not for sassafras.

Data obtained in this study fail to show any difference in effectiveness between alkyl esters of 2,4-D and 2,4,5-T and the more expensive glycol ester formulations.

Kerosene was a more effective carrier than paste for almost all 2,4-D and 2,4,5-T formulations on both persimmon and sassafras.

Sassafras generally responded to treatment more quickly than persimmon and showed consistently higher apparent kill. However, the difference between species in apparent kill became smaller with each succeeding observation.

These results suggest that for killing sassafras, 2,4-D is just as effective as 2,4,5-T, which is more expensive. Also, since it is about equally susceptible to all formulations, relative cost might well be the dominant factor in deciding which formulation to use on sassafras. On the other hand, since only the ester forms of 2,4,5-T have given consistently satisfactory results on persimmon, they should be specified for that species.

Successive observations on apparent kills resulting from basal bark applications of 2,4-D and 2,4,5-T on persimmon and sassafras showed that the earlier observations were conservative rather than exaggerated. However, even after three growing seasons, results on persimmon and sassafras must be considered preliminary because at least some of the root systems are still alive and may be capable of sprouting.

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